

Effect of Lung Surfactant Proteins on the Properties of Surfactant Lipids

W.K. Fullagar, I.R. Gentle (University of Queensland, Australia)

Beamline(s): X19C

The objective of this research is to reveal the mechanism of action of pulmonary surfactant protein SP-B, which is known to be crucial in proper pulmonary function. This small (79 amino acid) homodimeric protein interacts with phospholipids at the air-water interface in the lungs, and appears to mediate their transformation to and from a variety of structures in the subphase during the breathing cycle.

The surface density profiles shown in Figure 1 show the results of fits to data obtained at NSLS Beamline X19C in March 2001 upon increasing the surface pressure of a monolayer containing the primary pulmonary phospholipid (dipalmitoylphosphatidylcholine, DPPC) in admixture with SP-B isolated from sheep lungs. These results show, for the first time, tentative evidence of the formation of multilayers at high surface pressure, which is likely to be the initial step in the formation of subphase vesicles. In conjunction with similar measurements of pure phospholipids, the data obtained so far also supports the hypothesis that one of SP-B's functions is to influence the 2-dimensional liquid-expanded to liquid-condensed phase transition that occurs in DPPC. Other measurements we have performed at X-19C, of pure sheep SP-B at the air-water interface, suggest that several of the sulfur atoms in the protein are clustered $\sim 10\text{\AA}$ from the air interface, a fact which may assist in determining the orientation of the protein on the surface. These observations form a crucial component of a forthcoming publication.

As part of the same project we have measured the neutron reflectivity of SP-B isolated from cows as well as a related synthetic peptide sequence, mixed with deuterated and non-deuterated DPPC. Such measurements, some of which also show evidence of multilayer formation, provide supporting evidence and further constraints on the interpretation of the density profiles shown in Figure 1.

Future work will seek to address the effects of other parameters also, such as pH, temperature and the effect of anionic phospholipids. The latter are believed to be particularly important in pulmonary surfactant owing to the cationic nature of SP-B under physiological conditions.

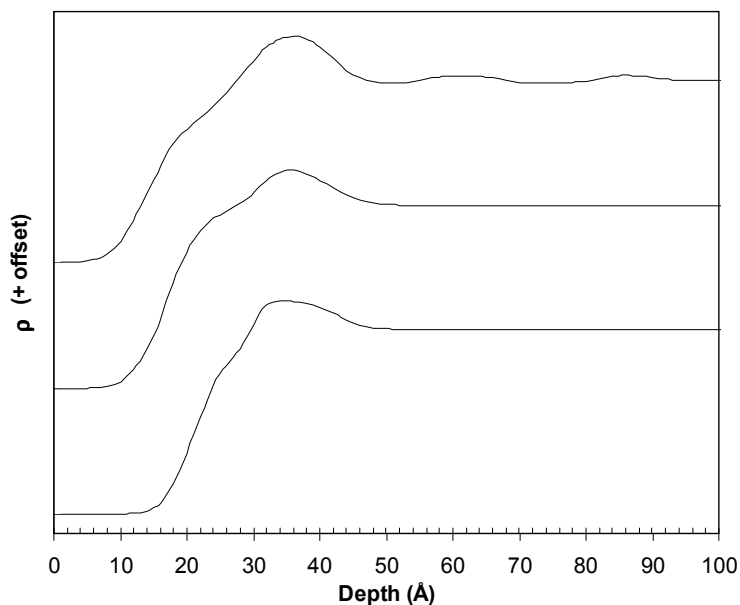


Figure 1: The evolution of the surface scattering density profile of sheep SP-B:DPPC 1:20 mol ratio mixture on aqueous buffer at increasing surface pressure. Bottom to top: $\Pi \approx 5\text{mNm}^{-1}$, $\Pi \approx 20\text{mNm}^{-1}$, and $\Pi \approx 55\text{mNm}^{-1}$, respectively